National Hydrologic Assessment

March 17, 2016

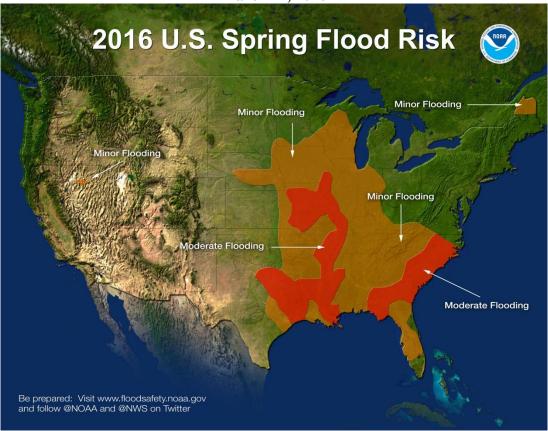


Figure 1: National Spring Flood Risk defined by risk of exceeding Minor, Moderate, and Major Flood Levels

Executive Summary

Analysis of flood risk and water supply integrates late summer and fall precipitation, frost depth, soil saturation levels, stream flow levels, snowpack, temperatures and rate of snowmelt. A network of 122 weather forecast offices and 13 river forecast centers nationwide assess this risk, summarized here at the national scale. Areas across the country that are at risk of exceeding moderate or minor flood this spring are shown in Figure 1.

The Mississippi River from Iowa to Louisiana is expected to exceed moderate flooding this spring. December 2015 was the wettest December on record for the contiguous United States, according to the NOAA National Centers for Environmental Information (NCEI), bringing major to record flooding on the Mississippi River and its major tributaries in late 2015 into early 2016. Heavy rains over multiple days caused flooding along the Mississippi, Illinois, Ohio, Meramec, and Arkansas Rivers. A mild winter has prevented buildup of a snowpack, and shallow frost depths, combined with winter flooding and recent heavy rains has resulted in soil moisture and streamflows remaining high throughout much of Iowa, southern Wisconsin, and

northwest Illinois. These conditions bring with them the threat of exceeding minor flooding on tributaries to the middle Mississippi and streams and rivers throughout Wisconsin, Iowa, Illinois, and Indiana. On the lower Mississippi, streamflows in early March were already elevated from winter flooding, when heavy rainfall fell across east Texas and northwest Louisiana. This heavy rainfall, exceeding 20 inches in parts of northwest Louisiana, caused widespread moderate to major flooding. Saturated conditions contribute to the risk of moderate flooding on rivers across eastern portions of Texas, northern Louisiana, and on the mainstem lower Mississippi River.

Winter precipitation was also well above normal across the Southeast, with numerous locations across the region setting December records. Additional spring rains on wet soils and normal to above normal streamflows in this region will contribute to the potential for exceeding moderate flooding on rivers in North Carolina, South Carolina, Georgia, and Florida.

Small streams and rivers in the lower Missouri basin typically experience minor to moderate flooding during the springtime. Wet soils in the eastern part of the lower Missouri basin in Missouri, northwest Iowa, and eastern Kansas will increase susceptibility to flooding due to individual convective rain storms typical in the spring, with a risk of moderate flooding in the Grand, Platte, and Osage River basins, and along many of the smaller streams feeding the Missouri River downstream of Kansas City.

Rivers and streams in the Ohio River basin and the Tennessee and Cumberland River Valleys typically experience minor flooding in the springtime. There is a near-term risk of exceeding minor flooding due to early March heavy rains. The threat of minor flooding will persist throughout spring. Any increase in flood potential will be driven by individual convective rainstorms typical in the spring.

The Red River of the North typically experiences minor to moderate flooding during the springtime. However, with normal to below normal snowpack in this basin, any flood potential will be driven by individual convective rainstorms typical in the spring. This is the second year in a row that the Red River of the North basins have been predicted to have a chance of minor flooding that is less than historical average.

The flood potential from snowmelt and ice jams throughout Alaska this spring is currently rated as normal. This forecast is based on current ice thickness, observed snowpack, and long-range weather forecasts. Typically, Alaska snowmelt and ice jams occur in the late April to early June time frame. Bi-weekly updates to the flood potential from snowmelt and ice jams are provided by the Alaska Pacific River Forecast Center and can be obtained here.

Heavy rainfall at any time can lead to flooding, even in areas where overall risk is considered low. The latest information for your specific area, including official watches and warnings should be obtained at http://water.weather.gov.

Current water supply forecasts and outlooks in the western United States range from near normal in the Pacific Northwest, Sierra Nevada, and western Great Basin, near to below normal in the upper Colorado River basin, near to much below normal in the eastern Great Basin, to below normal in the Northern Rockies.

Heavy Rainfall and Flooding

The information presented in this report focuses on spring flood potential, using evaluation methods analyzed on the timescale of weeks to months, not days. Heavy rainfall at any time can lead to flooding, even in areas where overall risk is considered low. Rainfall intensity and location can only be accurately forecast days in the future, therefore flood risk can change rapidly.

Stay current with flood risk in your area with **the latest official watches and warnings at** <u>weather.gov</u>. For detailed hydrologic conditions and forecasts, go to <u>water.weather.gov</u>.

NOAA's Experimental Long Range River Flood Risk Assessment Greater than: 50% ▼ chance of exceeding river flood levels during Mar-Apr-May ▼ Switch Baseman Click on the map or select one of the data views Reset View United States NWS Weather Forecast Offices NWS River Forecast Centers Water Resources Regions Show locations with 50% or greater chance of flooding during Mar-Apr-May (303) 1 Gauges: > 50% Major Long-Range Flood Risk
39 Gauges: > 50% Moderate Long-Range 263 Gauges: > 50% Minor Long-Range 2090 Gauges: < 50% Long-Range Flood 71 Gauges: No forecast within selected **■USGS** Show all locations Esri, DeLorme, FAO, NOAA, USGS, EPA

Figure 2: Greater than 50% chance of exceeding minor, moderate, and major river flood levels during March – April - May

At the request of national partners including FEMA and the US Army Corps of Engineers, NOAA continues its improved decision support services with the "Experimental National Long Range River Flood Risk" web page available at http://water.weather.gov/ahps/long_range.php. Here, stakeholders can access a single, nationally consistent map depicting the 3-month risk of minor, moderate, and major river flooding. This risk information is based on NOAA Ensemble Streamflow Prediction (ESP) forecasts that are generated for thousands of river and stream forecast locations across the nation. With this new capability, a stakeholder, such as a local emergency manager, can quickly view flood risk at the levels that are known to affect their specific area of concern. These enhancements improve the value of the National Hydrologic Assessment, by clearly and objectively communicating flood risk at the local level.

The sections below quantify river flood risk based on the river location having a 50% or more likelihood of exceeding minor, moderate, or major flood levels. The National Weather Service (NWS), in coordination with local officials nationwide, defines flood levels for each of its river forecast locations, based on the impact over a given area. The flood categories are defined as follows:

- **Minor Flooding** minimal or no property damage, but possibly some public threat (e.g., inundation of roads).
- **Moderate Flooding -** some inundation of structures and roads near stream. Some evacuations of people and/or transfer of property to higher elevations.
- **Major Flooding -** extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

For example, on the Red River of the North at Fargo, ND, Moderate Flood Stage is 25 feet. At that height, city parks and recreation areas near the river are impacted. The impacts of all floods are local and, as such, this information is unique for each forecast location. To access local flood impact information, visit <u>water.weather.gov</u> and click on any river service location

Risk of Exceeding Major Flooding

While there are no widespread areas with risk of exceeding major flooding, springtime heavy rains in areas with saturated soils may cause localized major flooding. Without significant snowpack across most of the country, the flood risk is highly dependent on the amount of future rainfall in areas with above normal soil moisture and streamflow.

Risk of Exceeding Moderate Flooding

Middle and Lower Mississippi Basin

There is a chance of exceeding moderate flooding on the middle Mississippi River due to high soil moisture and streamflows throughout much of the region. Locations in Iowa, southern Wisconsin, and northwest Illinois have experienced recent snowmelt and rainfall, and saturated soils, bringing a threat of exceeding minor flooding on tributaries to the Mississippi in that area.

On the lower Mississippi and Atchafalaya Rivers, streamflows in early March were already elevated from winter flooding, when additional rainfall exceeding 20 inches in some locations fell in northeast Louisiana, causing widespread moderate to major flooding. Saturated conditions from this flood event will contribute to the vulnerability of moderate flooding during the spring on the lower Mississippi, Atchafalaya, and lower White River in Arkansas. There is a risk of exceeding minor to moderate flooding in Mississippi on the Pearl and Big Black Rivers.

Lower Missouri Basin

The lower Missouri basin in Missouri and eastern Kansas has a threat of moderate flooding through spring. This flood potential will be driven by individual convective rainstorms typical in the spring, as average to below average mountain snowpack is unlikely to cause significant flooding from snowmelt. Moderate flooding is possible in eastern Kansas in the Marais des Cygnes River basin, and along Stranger Creek, in Iowa along the lower Big Sioux River, and in Missouri in the Grand, Platte, and Osage River basins, and along many of the smaller streams feeding the Missouri River downstream of Kansas City. Forecast locations along the mainstem Missouri River that may experience minor flooding are those downstream of Nebraska City. Minor flooding is also possible along with Platte River and smaller streams in

southeastern Nebraska, in Iowa in the Little Sioux, Rock, and Nishnabotna River basins, in the Big Blue River basin in Kansas, and along the Chariton River in Missouri.

Eastern Texas

2015 was the wettest year on record for Texas, according to NCEI, ending a 5-year drought. Although the region experienced a drier than normal January and February 2016, additional heavy rains in early March brought major to record flooding along the Sabine, Neches, Trinity, and Navasota Rivers. There is little capacity for streams and soils to absorb additional water and conservation reservoirs in this region have little capacity to deal with additional floodwaters, so any additional precipitation this spring will likely exacerbate flooding. A number of locations, including along the Sabine and Trinity Rivers, are projected to exceed moderate flooding through the spring.

Southeastern United States: Alabama to North Carolina

Moderate flooding is possible in the Southeast, including Alabama, Georgia, northern Florida, South Carolina, and North Carolina. This flood potential is driven by individual convective rainstorms typical in the spring falling in basins where near to above average soil moisture conditions exist.

Risk of Exceeding Minor Flooding

Ohio Valley, Tennessee and Cumberland Valleys

While snowpack in the upper reaches of the Ohio is limited, wet soils in the Western part of the lower Ohio River basin and elevated streamflows from heavy rains in early March will increase susceptibility to flooding during the early spring for the lower Ohio and Cumberland and the Tennessee River basins. This risk will be driven by individual convective rainstorms typical in the spring. A risk of minor flooding exists on the Wabash, Little Wabash, White and Maumee basins through Illinois, Indiana, and Ohio, in the Kentucky and Green River basins, and in West Virginia in the Monongahela and Little Kanawha basins. There is a chance of exceeding minor to moderate flooding in the Tennessee River basin.

Humboldt Valley, Nevada

Snowpack in the Great Basin of Nevada is near to above normal, and above average in the Humboldt River basin. This brings the potential for exceeding minor flooding due to snowmelt flooding along the Humboldt River.

Northern Maine

The abnormally warm winter has limited the build-up of snowpack over most of New England, with the exception of Northern Maine. The possibility of snowmelt driven flooding brings a risk of exceeding minor flooding in this area.

Other Regions/Low Flood Risk Areas

Pacific Northwest

Weather patterns in this part of the country are markedly different west and east of the Cascade Mountain Range, which define the difference in flood threat.

West of the Cascades - Rivers west of the Cascade crest usually reach their highest peak flows during the winter. Due to orographically induced precipitation, the vast majority of river flooding in western Washington, and almost all major floods, occur between November and March. Spring snowmelt comes too late to add to this threat, this year is no different.

East of the Cascades - Rivers east of the Cascades reach their annual peak in late spring or early summer when the mountain snowpack melts and runs off. The snowpack usually reaches its annual maximum in April and rivers typically crest between mid-May and mid-July. As a general rule, the larger the snowpack is at the end of the season, the higher the river crests will be.

Even with a lower spring flood risk, some smaller streams and flood prone rivers may experience minor flooding with a sudden large warm-up or the occurrence of heavy rain or thunderstorms over those watersheds. Flooding during the snowmelt season can occur anywhere when heavy rain falls in a river basin if the rain is intense enough.

Western Texas and the Southwest including California

There is very low chance of flooding over the southwestern United States, as drought continues to impact the region. The primary factor in development of significant river flooding over most of the region is the occurrence of excessive rainfall in relatively short periods of time, even for areas where drought conditions persist or have developed.

Please visit drought.gov for detailed outlooks, impacts, and information related to your area.

Western U.S. - Regarding Spring Flood Prediction

Mid-March is still too early to determine final spring flooding potential across the western United States due to snowmelt. Snowpack in the Pacific Northwest is generally near normal except for the Rocky Mountains where is less than normal. This is especially true for the upper headwaters of the Snake River where snow water equivalent is commonly 70 to 90% of average. Current snowpack is also less than normal across much of Oregon due to recent meltoff.

Snowpack in the Great Basin of Utah, Idaho, and Wyoming is below normal for this time of year. Snowpack is highly variable throughout the upper Colorado River basin but in general near or below normal. Spring flooding due to snowmelt is not anticipated at this time in these areas.

Snowpack in the Great Basin of Nevada is near to above normal, and above average in the Humboldt River basin. The potential for snowmelt flooding is above average along the Humboldt, but not anticipated in the eastern Sierra.

There is still ample time left in the accumulation period for the spring flood potential to change. Snow accumulation typically occurs into April in many higher elevation areas. Weather conditions preceding and during the melt period determine the threat of flooding. Rapid warming

can lead to elevated melt rates. During the melt, when rivers and streams are flowing at or near capacity, any precipitation can increase the risk of flooding. As always, citizens are encouraged to monitor the forecasts from their local Weather Forecast Offices.

Western Water Supply

Water supply forecasts are produced for mountainous basins in the western United States that supply water for agriculture, municipalities, and industrial uses. Forecasts reflect current hydrologic conditions including snow pack, soil moisture, and weather and climate outlooks. As these conditions change, especially over the next couple of months, forecasts will be updated to reflect these changes. Water supply forecasts are generated by NOAA/NWS River Forecast Centers and the Natural Resources Conservation Service (NRCS) National Water and Climate Center.

Current water supply forecasts and outlooks in the western United States range from near normal in the Pacific Northwest and Sierra Nevada, near to below normal in the upper Colorado River basin, near to much below normal in the Great Basin, and below normal in the Northern Rockies:

- Snake and Columbia Rivers Median forecast is 95% of average for the Snake River at Lower Granite Dam and 100% of average for The Columbia River at The Dalles.
- Missouri River Median forecast at Toston is 76% of average
- Colorado River Median forecast inflow to Lake Powell is 80% of average
- Eastern Great Basin (Utah) Median forecasts range from 45% to 90% of average for most locations.
- Western Great Basin (Nevada) Median forecasts range from 64% to 159% of average, most are near or slightly above average.
- California Median forecasts range from less than 50% of average upward to 100% of average

These wide-ranging water supply forecasts reflect the stark contrast in weather patterns between the northern and southern portions of the region.

Upper elevation areas in the headwaters of the Columbia River basin, including portions of British Columbia and eastern Washington, have received above average seasonal precipitation. These regions are strong contributors to the Columbia River. However, below average precipitation has fallen along the northern Rockies from Montana through Idaho and Wyoming. Snowpack is near average over much of Washington and central Idaho, but is below average in western Montana and northern and southeastern Idaho. Median forecasts parallel the current snow conditions, with near average numbers for most basins. However, below average runoff is projected along the Rockies in western Montana and eastern Idaho, as well as in the lower elevation basins in northern Idaho and along the southern Snake River plain.

Water year precipitation in the Upper Colorado basin ranges from 70 to 130 percent of average. Headwater locations that produce the bulk of the water supply are generally near average, ranging from 90-100 percent of average. Snowpack in the headwaters is highly variable. A few areas are near or above normal however, below normal conditions are more widespread. Soil moisture in this area is below average due to a warm and dry fall. Water supply forecasts

range from 65 to 100 percent of average at specific points. Inflow into Lake Powell is expected to be near 80% of average.

In the Lower Colorado basin, including southern Utah, Arizona, and western New Mexico received water year precipitation ranging from 70 to 150 percent of average. Mid-winter snow conditions were near to above normal but most snow has melted as of March 1st with the exception of southern Utah. Streamflow volume forecasts in the Lower Colorado River basin for the January-May period call for above median runoff in the Gila River basin, near to below median volumes in the Salt and Verde River basins, and near to above median volumes in the Little Colorado River basin. Reservoir storage in the Salt River basin is near 55 percent of capacity, Gila River basin 15 percent of capacity, and Little Colorado River basin 40 percent of capacity.

Water year precipitation in the eastern Great Basin ranges from 70 to 100 percent of average. Snowpack conditions are generally below average with the exception of a few locations. Water supply forecasts range from 45 to 90 percent of average. Conditions are more favorable in the western Great Basin, were water year precipitation ranges from 100% to 140% of average and snowpack conditions are near average. Water supply forecasts in the Nevada portion of the Great Basin range from 64% to 159% with most close to or slightly above average.

Precipitation ranges from near to above normal for the water year across northern California and throughout a good portion of the Sierra. The coastal areas have received below average rainfall from the northern bay area through southern California. Statewide snow water content is approximately 77% percent of the April 1st average. The April through July streamflow volume is forecast to be at or near normal for the majority of streams across the state.

The water supply situation is improving rapidly across the state as a result of the early March storms. Storage for the major reservoirs in northern California range from 53-124% of average (40-71% of capacity) with continued improvement expected. Storage in the San Joaquin and Tulare basin reservoirs range from 34-86% of average (21-57% of capacity). This year's near normal snowpack in the mountains will help stabilize reservoir storage throughout the summer and fall to some extent, but will not end the multiple years of drought.

Water Resources East of the Rockies

Projections of surface water availability provided by the National Weather Service play a crucial role in water resource decision making in other regions of the country. The last six months has brought above normal precipitation to eastern New Mexico and West Texas, but recent lack of precipitation has caused development of <u>abnormally dry conditions</u> in this area. The <u>US Seasonal Drought Outlook</u> indicates that the dryness will persist across portions of New Mexico, West Texas, and the Oklahoma panhandle.

Alaska Spring Ice Breakup Outlook

The flood potential from snowmelt and ice jams throughout Alaska this spring is currently rated as normal. This forecast is based on current ice thickness, observed snowpack, and long-range weather forecasts.

Ice Thickness

March ice thickness data are available for a limited number of observing sites in Alaska. March 1st measurements indicate that ice thickness is generally normal to below normal across the state. Accumulated freezing degree days are significantly below normal across the state with most locations south of Alaska Range being near 50% of normal. River freeze-up stage during the fall of 2015 was higher than normal on the Kuskokwim and Yukon rivers, which is correlated with increased spring ice jam potential.

Snowpack

An analysis of the March 1st snowpack by the Natural Resources Conservation Service (NRCS) indicates near normal snowpack in the Upper Yukon and Kuskokwim basins with below normal to well below in the southcentral and southeast. For more details, please refer to the various snow graphics from <u>APRFC</u> or from the <u>NRCS</u>.

Weather Forecasts

The most important factor determining the severity of ice breakup remains the weather during April and May. The preliminary outlook for the next 90-days suggests an increased chance of above normal temperatures for Alaska. If daily temperatures are consistently above normal over the next two months interior and southcentral Alaska breakup will be earlier than normal. For more information on the climate forecasts please refer to the Climate Prediction Center.

Spring Flood Outlook and Implications for Gulf of Mexico and Chesapeake Bay Hypoxia

The predicted spring flood risk across the Mississippi River watershed is anticipated to lead to above average hypoxic zone conditions in the northern Gulf of Mexico this summer. Flood risk is moderately higher over major portions of the Upper and Lower Mississippi River basins with most of the Ohio River basin predicted to be normal. These basins contribute the majority of nutrients flowing down the Mississippi river and flood conditions, should they occur, may lead to higher than normal springtime discharges of nutrients and freshwater from the Mississippi River into the Gulf of Mexico, conditions that promote hypoxia formation and spread. This cause and effect relationship, however, can be confounded by weather events such as tropical storms and hurricanes, which can locally disrupt hypoxia formation and maintenance.

In the northern Gulf of Mexico each year a large area of low-oxygen forms in the bottom waters during the summer months, often times reaching in excess of 5,000 square miles (the average area since 1985 is 5,312 square miles). This area of low-oxygen, otherwise known as the "dead zone", is strongly influenced by precipitation patterns in the Mississippi-Atchafalaya River

Basin (MARB) which drains over 41% of the contiguous United States. Changes in precipitation will influence river discharges into the Gulf which carry the majority of nutrients helping to fuel the annual dead zone, so examining spring flood risk in the MARB can provide a useful indicator of the possible size of the dead zone.

Another system with recurring summer hypoxia is the Chesapeake Bay. Hypoxia in the Chesapeake Bay has also been linked to nutrient loadings and river discharge, especially from the Susquehanna and Potomac Rivers. With the absence of any predicted flooding in these basins, we anticipate the size of hypoxia in the Chesapeake Bay will be average for 2016. This assumes typical summer conditions in the Bay region and the absence of major disruptive events such as tropical storms and hurricanes.

The spring flood outlook provides an important first look at some of the major drivers influencing summer hypoxia in the Gulf of Mexico and Chesapeake Bay. In early June, the actual river discharge rates and corresponding nutrient concentrations will be available from USGS. This information will be used by NOAA's National Ocean Service to release its annual dead zone forecast for the Gulf of Mexico and Chesapeake Bay which will provide an actual forecasted dead zone size based on the available nutrient loading data. In June and July, the dead zone sizes will be measured and compared against the predictions.

NOAA's Role in Flood Awareness and Public Safety

Floods kill an average of 89 people each year in the US. The majority of these cases could have been easily prevented by staying informed of flood threat, and following the direction of local emergency management officials.

To help people and communities prepare, NOAA offers the following flood safety tips:

- Determine whether your community is in a flood-risk area and continue monitoring local flood conditions at http://water.weather.gov.
- Learn what actions to take to stay safe before, during, and after a flood at www.floodsafety.noaa.gov.
- Visit http://www.floodsmart.gov to learn about FEMA's National Flood Insurance Program and for flood preparedness advice to safeguard your family, home and possessions.
- Purchase a <u>NOAA Weather Radio All-Hazards</u> receiver with battery power option to stay apprised of quickly changing weather information.
- Study evacuation routes in advance and heed evacuation orders.
- <u>Turn Around, Don't Drown</u> never cross flooded roads, no matter how well you know the area or how shallow you believe the water to be.

NOAA's National Weather Service is the primary source of weather data, forecasts, and warnings for the United States and its territories. It operates the most advanced weather and flood warning and forecast system in the world, helping to protect lives and property and enhance the national economy. Visit us <u>online</u> and on <u>Facebook</u>.

NOAA's mission is to understand and predict changes in the Earth's environment, from the depths of the ocean to the surface of the sun, and to conserve and manage our coastal and marine resources. Visit us online or on Facebook.

About this Product

The National Hydrologic Assessment is a report issued each spring by the NWS that provides an outlook on U.S. spring flood potential, river ice jam flood potential, and water supply. Analysis of flood risk integrates late summer and fall precipitation, frost depth, soil saturation levels, stream flow levels, snowpack, temperatures and rate of snowmelt. A network of 122 weather forecast offices and 13 river forecast centers nationwide assess this risk, summarized here at the national scale. The National Hydrologic Assessment depicts flood risk on the scale of weeks to months over large areas, and is not intended to be used for any specific location. Moreover, this assessment displays river and overland flood threat on the scale of weeks or months. Flash flooding, which accounts for the majority of flood deaths, is a different phenomenon associated with weather patterns that are only predictable days in advance. To stay current on flood risk in your area, go to http://water.weather.gov/ahps for the latest local forecasts, warnings, and weather information 24 hours a day.

National Water Center March 17, 2016